

# The fragile Sustainability of the Concept of Unsafe Act

Karen Santos Silva<sup>1</sup>, Márcio de Queiroz Murad<sup>2</sup>

<sup>1</sup>Federal University of Lavras, UFLA, Engineering School, Lavras, MG, Brazil.

<sup>2</sup>Federal University of Triângulo Mineiro, UFTM, Technical College and Engineering School, Uberaba, MG, Brazil.

Received: 21 Feb 2021;

Received in revised form:

09 Apr 2021;

Accepted: 25 Apr 2021;

Available online: 14 May 2021

©2021 The Author(s). Published by AI

Publication. This is an open access article  
under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

**Keywords**— *Work safety; accidents at  
work; Unsafe Act; accident analysis,  
sustainability.*

**Abstract**— *Beliefs regarding causes of accidents at work as “unsafe act” or “unsafe condition” have ruled the completion of work accident reports in a simplistic and inefficient way. It is noticed that the concept of blaming the worker prevails in most of the literature on work accidents. Besides, the same bias may be noticed in most company registers, which are usually filled by those in charge of analyzing and preparing reports of work accidents in the organization. The conclusion of making the victim of the work accident guilty, tends to misrepresent the fault of the company or those in charge. In the present article, 311 work accidents occurred in a company of the sugar and alcohol sector within a two years period were analyzed. The amount of 196 accidents characterized as “unsafe acts” was identified. The analysis was used using ABNT NBR ISO 31000 (2009) and which suggests the Root Cause Analysis tool, which aims to identify hidden causes in reported accidents. The theoretical framework for analysis was built from specific Brazilian legislation and technical standards. As a result, the disclosure of root causes of the accidents at work indicated that the “unsafe act” concept is fragile and inconsistent, which made it possible to de-characterize the original concept of “unsafe act” defined by the company.*

## I. BIBLIOGRAPHIC REVIEW

It is noticed that the NBR 14280/2001 (ABNT, 2001), legitimizes the classification of accidents in "unsafe act and" unsafe condition ". From then on, it is possible to observe the creation of a paradigm, that an accident at work has only two causes, the “unsafe act” or the “unsafe condition”, consolidating the simplistic and inefficient way of concluding a report of an accident at work or not to go deeper into the studies of the real causes of accidents at work.

According to Chi et al. (2012), in the daily production process of companies, work safety is affected by a series of risk factors, one of which is described as human error (unsafe act). The same author states that such deviations are characterized as errors of judgment or improper operation. Castro and Okawa (2016), reaffirm this assumption when describing that the risky behaviors

that lead to the occurrence of the accident also lead to injury.

In an analysis of 104 reports, registered by the Criminal Institute of a city in the interior of São Paulo, which investigated the causes of accidents that occurred, 80.3% were attributed to "unsafe acts" and 19.7% to "unsafe conditions" (Vilela et al., 2004). In their study, Tong et al. (2018) analyzed a total of 225 accidents that occurred in coal mines and presented the interaction between the different dimensions of workers' unsafe behavior.

Such statements are consistent with that described in the work of Heinrich (1936), who presented the concept of “unsafe act” and indicated that this was the main cause of accidents at work and that they accounted for 88% of cases. Many other sources suggest that "unsafe acts", as a predominant way of addressing this issue, is to consider

the worker as a danger, a component of the system whose "unsafe acts" are implicated in most catastrophic failures (Reason, 2017).

Almost a century after Heinrich (1936) cited "unsafe acts" and advances in the field of accident analysis and prevention management, it is also noted that the concepts that hold workers responsible for the accidents of which they are victims are still maintained nowadays (Reason, 2017). Vilela (2004), adds by stating that the explanatory monocausal model centered on the victim's guilt has remained untouchable in the technical industrial environment, in the most conservative academic circles and in official bodies.

Such statement is ratified when the "social acceptability" of the accident analysis method is notorious, which is based on the opposition between "unsafe act and" "unsafe condition", technically legitimized by the Brazilian Association of Technical Standards (ABNT) when publishing the NBR 14280 standard / 2001 (ABNT, 2001), as explained by Jackson Filho et al. (2013). It is questioned here whether an accident is considered to be such a simple event to which only two causes can be attributed, the "unsafe act" or the "unsafe condition".

When evaluating different models of accident reports, the existence of the field "cause ascertained" is perceived, and the use of the singular in this denomination reveals the simplistic nature with which the accident is seen, and referring the researcher's option to choose between the "unsafe act" and the "unsafe condition", as explained by Vilela et al. (2004). The investigations of accidents that blame the victims and emphasize the responsibility of the worker under all circumstances, are adopted behind the scenes of companies (Reason, 2017).

One of the roots of blaming the victim for the accident is the lack of information or the imperfect training of professionals related to work safety (De Oliveira et al., 2007). Despite the scientific discredit of these conceptions, it is clear that it is rooted in the culture of prevention, a fact that is proven by the great use and acceptance by businessmen, professionals in the field, public agents, researchers and workers (Jackson Filho et al., 2013).

Vilela et al (2004) question whether the silent maintenance would not be a demonstration that this model would be convenient and interesting to hide the real causes of accidents at work. In the light of this thought, the blaming of workers who are victims of accidents describes an efficient mechanism for making engineers and safety professionals not responsible, as well as management and the public companies or institutions involved in the misfortune (Jackson Filho et al., 2013).

Accidents do not happen, but are caused by design errors due to lack of management and planning. Reason (2017), classifies two conceptions of accidents as being "engineering" and "organizational". The first refers to intrinsic prevention actions, such as planning, quantifying events or associated aspects of occupational health and safety management systems and improvement in the work environment.

In the light of Law No. 6,514 / 77 (BRASIL, 2019a), in its article 157, it describes that it is up to companies:

*"II - Instruct employees, through work orders, as to the precautions to be taken in order to avoid accidents at work or occupational diseases."*

In this item of the law, it can be questioned whether all workers are really informed about the risks, whether they receive the necessary training, whether all tasks are demanded by order of service, whether the task was planned under the perspective of existing risks and for finally, if this task was analyzed using any risk management technique, aiming at anticipating it and mitigating such risks.

It is clear that it is the company's obligation to instruct employees, through service orders, to take precautions to avoid the accident. The company must make an assessment of the activity foreseeing such risks, and this can be done by risk management techniques, such as Preliminary Risk Analysis, Hazop, Failure and Effects Analysis or any other technique that anticipates and mitigates the risk accidents or occupational diseases.

Regarding risk assessment, Namian et al. (2018) in their studies revealed that workers are unable to identify a large proportion of risks in their workplaces. From this perspective, it can be questioned whether it is really correct to attribute to the worker the function of assessing all the risks present in their work tasks.

Regarding the organizational concept, Law No. 6,514 / 77 (BRASIL, 2019a) describes:

*"Art. . 157 - It is up to the companies:*

*I - Comply with and enforce safety and occupational medicine standards".*

In this context, "comply" refers to the obligation to comply with laws. And with an emphasis on "enforcing", which refers to the thought that companies have a preventive management system and that does not allow any eventual deviation from the procedures, so it must provide actions or devices that curb this eventual deviation.

It can be exemplified as a deviation the fact that the employee, even if instructed, does not use personal protective equipment. However, this deviation cannot be considered as an “unsafe act”, as the company fails to “enforce” by demonstrating a weakness in its management system, by failing to inspect, raise awareness and provide really concrete actions in favor of this management of prevention. The term “enforce” suggests thoughts related to the commitment and obligation of companies in preventive management.

Another relevant aspect, which is the right and obligation of the company, is to punish an employee who, without justification, refuses to comply with the aforementioned service orders or company security procedures, as stated in article 158 of the Consolidation of Labor Laws (Brasil, 2019b) and such omission on the part of the company is evidenced as a management failure.

According to Zhang et al. (2019), that safety leadership and group-level organizational climate had a significant effect on workers' behavioral performance. These elements contribute to confirm that the influences of the leadership contribute to the management of accident prevention, and can contribute positively or negatively.

This element alone, when negative, is considered to be an “unsafe condition”. Returning to the example, that when a worker stops using individual safety equipment, and this event cannot be considered as an “unsafe act” because it refers to a weakening of his management system, to the extent that he does not exercise his punishment obligation.

It is emphasized here that the responsibility for occupational safety management is not the sole responsibility of the occupational safety engineers and technicians, as shown by the studies by Zhang et al. (2019), who states that the following actors were considered influential in the performance of occupational safety: safety professionals (safety engineers and occupational safety technicians), professionals in the project area, as stated by Geminiani et al. (2013) and operation.

It should be noted here that in terms of responsibility, leaders (managers, supervisors, coordinators, among others) are primarily responsible for ensuring that procedures related to work safety are complied with, and not work safety professionals, as this has the development function, not policing. Jackson Filho et al. (2013), explain that “blame attribution” allows most organizations to solve their own organizational problems.

Vilela (2004) highlights the fact that the legal theory about accidents at work is based on subjective responsibility, based on the need to show the employer's

guilt to support civil and criminal processes. In the Brazilian Civil and Penal Codes, they state that there is no civil reparation or criminal prosecution when the accident occurred "due to the victim's exclusive fault".

Jackson Filho et al. (2013), that accident analysis is always influenced by the analyst's view or understanding of these events. It should be noted that the occupational safety manager is responsible for developing the company's safety procedures and will also be responsible for analyzing the accident. The values implicit in a given conception are not always clearly assumed or understood by that same analyst, as explained by Vilela et al. (2007).

When stating that analysts are the professionals responsible for promoting occupational safety (engineers and safety professionals), the attribution of blame to workers who are victims of accidents is typically a mechanism to make these professionals, as well as the management and the companies themselves, responsible.

From the above, it is evident that the fact that whoever is responsible for the elaboration of procedures related to work safety will be responsible for the investigation of the accident and, in this situation, he would have as an option the characterization of the “unsafe condition” exposing the weaknesses of the organizational systems and engineering that is responsible for characterizing it as an “unsafe act” when attributing the blame to the victim.

Jackson Filho et al. (2013) present an idea launched at the Work Accident, Analysis, Prevention and Associated Aspects Forum, in 2013, by the Universidade Estadual Paulista - Unesp, through its coordinating group, which proposed a public manifest aimed at banning accident analysis methods based on unsafe acts, which lead to the blaming of workers, victims of accidents.

Llory and Montmayel (2010) corroborate these thoughts when they affirm that, from a scientific point of view and, in particular, from the state of the art of research in the field of analysis of catastrophes and accidents at work, the persistence of the use of the notion of unsafe act it is unacceptable. De Oliveira et al, (2007), suggest that the lack of information or imperfect training of professionals related to work safety, has contributed to aggravate this problem.

As a way of mitigating this situation, that is, imperfect training of professionals, many quality management tools are presented to contribute to the solution of this impasse. Explain Neto et al. (2019), that the great acceptance of the market for these tools, expanded the approach to many other sectors, where it mentions the protection to the environment and the safety and health of the worker.

Corroborating this thought, Kuendee (2017) reports that quality tools can be used in any activity of the institution. Ratifying the same premise, claim Da Costa Almeida et al. (2019), that quality tools can work in conjunction with process management techniques in addition to the management of support areas. As a benefit, the use of these tools ensures the integration of several systems within the organization (Neto et al., 2019).

The ISO 31000 is a standard in the risk management family created by the International Organization for Standardization. The purpose of this standard is to establish general principles and guidelines on risk management. ISO 3100 consists of three standards:

- a) ISO 31000 - Basic information, principles and guidelines for the implementation of risk management.
- b) ISO / IEC 31010 - Risk assessment and management techniques.
- c) ISO Guide 73 - Vocabulary related to risk management.

ISO / IEC 31010 is a standard created by the International Organization for Standardization (ISO) in partnership with the International Electrotechnical Commission (IEC). which was translated by ABNT as "NBR ISO 31010: Risk management: Techniques for the risk assessment process". This is not a standard for certification, but for supporting ISO 31000, bringing tools for carrying out risk assessments (De Oliveira et al., 2017). This standard presents 31 tools, including the Root Cause Analysis (RCA) tool, also known in Quality Management as "5 why".

RCA consists of a technique capable of identifying the main causes for a given problem, which avoids an unnecessary focus on solving its "symptoms", to the detriment of its cause, as explained by Da Costa Almeida et al. (2019).

Regarding the execution of the technique, Aguiar (2014) suggests that the first "why" should be elaborated based on the cause raised, answering the reason for the problem's occurrence. The second, on the other hand, must be applied based on the answer of the first "why" and so on, until the main cause of the problem is raised.

In the context presented so far, an analysis of an accident history of a company in the sugar and alcohol sector will be carried out. In this, the accidents that were observed by the company representative will be investigated, where they were characterized as an "unsafe act". For this, a technique called RCA will be applied, as a tool to determine the causes of the unwanted event.

## II. METHODOLOGY

A company in the sugar and alcohol sector (company will not be identified), made available a report of accidents that occurred between the period of 2017 and 2018 (two years) and a description of 311 accidents. This report presented the causes attributed by the company's representatives, classified as "unsafe act" and "unsafe condition". With the descriptions and details of the events that obtained the classification "unsafe act", the RCA technique was applied.

In Tables 1 to 3, in the "Accident Description", the description of the accident given by the company's representatives is presented. The application of the RCA tool is also presented, where it was directed to the identification of root causes of the accident. In the "legal analysis" section, a framework was sought to legitimize or reclassify the concept attributed by the company's representatives. Finally, in the section "Risks Identified by the RCA Methodology", the causes of the accident are presented, identified by the application of the tool.

The results of the analyzes were compared and discussed from the point of view of whether the classifications defined as "unsafe acts" were applied correctly, that is, if there was no evidence of failure on the part of the company, thus configuring an "unsafe condition".

## III. RESULTS AND DISCUSSION

Figure 1 shows the classification (in percentage), of the causes of accidents at work, extracted from the reports, in which 311 accidents belonging to the groups of accidents with and without lost time, accidents with and without victims and with material damage were totaled. . Of this total, 196 accidents (63%) were classified by the analyst as "unsafe acts" and the remainder as "unsafe condition".

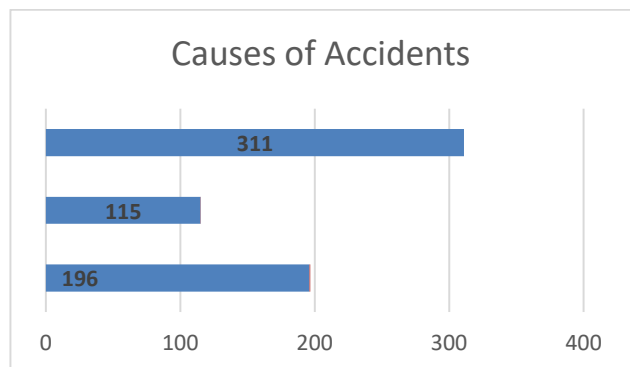


Fig.1: Causes of accidents



After analyzing the 196 accidents reported as “unsafe acts”, using the RCA technique, we sought to identify the root causes to justify what happened. Due to the large volume of information, only three analyzes were presented in this text.

In Tables 1 to 3, the investigations of the event carried out by the company representative were presented in the “accident description” field. In the “Why's” fields, the methodology is applied, in which it seeks to identify the cause (risks) hidden in the “description of the accident”. In the “legal analysis” fields, searches were made in the laws and technical standards, with the aim of identifying whether the classification carried out by the company (unsafe act) is correct.

Finally, in the fields “Risks Identified by Methodology”, some risks presented by the authors of this article are presented. After analyzing the 196 accidents reported as “unsafe acts”, using the RCA technique, it was found that in their entirety, legal bases were found in the legislation and technical standards that mischaracterize the concept of “unsafe act”.

In Table 1, during the evaluation of the accident that occurred (carried out by the company's representative), the type of accident was classified as an “unsafe act” because the maintainers started work with the pressurized equipment. It is evident, in this case, that the company does not comply with NR12 when it did not foresee in its project the installation of a pressure relief valve or any other device that ensures the maintenance of the equipment safely.

The fact that the workers started the procedure with high-calorie equipment is still under discussion, but the pressure for better work efficiencies in fulfilling numerous tasks during their workday was ignored. Would management accept the fact that the equipment would be idle for hours waiting for maintenance actions while it cooled down?

Ratifying the thinking of Zhang et al. (2019), that leaders can contribute positively or negatively. This element alone, when negative, is considered to be an “unsafe condition”. Another fact, presented in Table 1, is about the early risk assessment before the intervention of the equipment that did not occur.

Noncompliance with the legislation is also present in the analysis of Table 2, where ergonomic aspects and safe access to the equipment were not appreciated in the design and installation phases. It is evident that it is normal for employees to perform tasks in a way that requires more comfort and less fatigue, and such needs must be part of a risk analysis in the installation and design of equipment and, also, for the release of the task in the operation.

The opening and closing of valves can be motorized or automated, providing more safety and comfort to operators. As explained by Zhang et al. (2019) and Geminiani et al. (2013), there is a significant influence of sectors in the project area on the performance of work safety.

In Table 3, in the description of the accident, it was stated that the employee did not pay attention when allowing the truck to leave after the cane was unloaded, as it would be usual for him to authorize the movement only when the other collaborators finished executing the task of uncoupling the truck. vehicle body.

Factors such as low-light night work (due to lack of maintenance) were evident, demonstrating the failure in the company's operational management to not guarantee the best working conditions. In terms of character, the confusion of characters and considering that all workers are in uniform, added to the low light of the place, required greater attention from the employee in carrying out the task. This confusion can also be attributed to a management failure, as these adverse conditions should be foreseen.

When analyzing NR 12, in that risk area, there should be a limitation in the traffic of people, in addition to guaranteeing those involved in the task visibility to ensure safe maneuvers, and these aspects were not observed by the company. As evidenced by Jackson Filho et al. (2013), points out that it is the company's role in developing safe operating procedures.

As a solution to this impasse, the use of stop and emergency buttons to be activated by employees G1 and G2, as provided for in NR 12 in its item 12.24, which determines that “The devices for starting, starting and stopping the machines must be designed” would resolve this issue, that is, the company did not meet NR 12.

According to Zhang et al. (2019), leadership in the company has a significant effect on the workers' behavioral performance and this fact was evident in situations in which the omission or lack of leadership allowed to make decisions that led to the occurrence of negative events. Defining the responsibilities of their subordinates, defining rules to be followed and using their authority to punish when necessary, are the attributions of leaders that converge in results in favor of accident mitigation.

The analysis also presented evidence in all situations that there was a failure on the part of accident reporters to not know or omit the current legislation, a fact that contributes to conceal the true causes of accidents at work, and does not hold engineers and professionals responsible security, as well as the management and the

companies or public institutions themselves involved in the misfortune, as exposed by Filgueiras et al. (2012); Jackson Filho et al. (2013) and Vilela (2004).

Regarding the RCA tool, it proved to be an option for application in accident assessment reports, as it deepens the analysis and presents the hidden causes and as suggested by Neto et al. (2019), Kuendee (2017) Da Costa Almeida et al. (2019).

#### IV. CONCLUSION

In light of the discussion of the concept of “unsafe act”, and corroborating with Jackson Filho et al. (2013), Vilela et al (2004), Reason (2017), Llory and Montmayel (2010), “blaming” allows most organizations to solve their own organizational problems. According to the results of the analysis, the accidents presented that received an initial classification given by the company's representative, as an “unsafe act” are easily uncharacterized by the content present in the laws and regulations. In addition, it demonstrates that companies rely on Brazilian legislation and use it to avoid civil reparation or criminal proceedings when the accident occurred “due to the victim alone.”

In another point of view, such failures of analysis, have a contribution of the fact that, the authors of the safety procedures are the same ones that evaluate the cause of the accident. In other words, they are given the choice between defining it as an “unsafe condition”, which refers to a weakness of these procedures and other aspects of management or the option to classify it as an “unsafe act” and to blame the victim, who is the most weak of this unfair condition. Paralleling the three powers, executive, legislative and judicial, proposed by Montesquieu and adopted by the Brazilian constitution, where the essence of this theory is based on the idea that these powers act separately and are supervised. When companies design procedures, conduct operational management, analyze, judge the causes of accidents and ultimately blame them, they would be playing the role of the executive, the legislature and the judiciary. And the result of this is the exacerbation of power and the ability to impose the truth itself.

In another reflection, the one who is responsible for the development of safe procedures, when in a simplistic way, has as a legal alibi, accusing the victim of the accident, will not have the need for his personal development, technically or morally, in his noble attribution of accident prevention. In this context, the results of the professionals are measured by the numbers of accidents. According to MTE statistics, these results have long been subject to no reduction (ANPT, 2019), and

demonstrate the low evolution in accident prevention practices.

Finally, attributing to an accident only the causes “unsafe act” and “unsafe condition” is an inefficient way to complete an accident analysis, as it has, as its sole purpose, “finding a culprit”. Such a form of analysis does not point to any risk, and also does nothing to prevent such an accident from recurring or the identification of other potential risks. Regarding the “5 whys” tool, it presents itself as an easy-to-use methodology that can be useful for identifying risks in the analysis of accidents that have occurred.

#### ACKNOWLEDGEMENTS

This work was supported by Instituto CEFORES from the Federal University of Triangulo Mineiro.

#### REFERENCES

- [1] Aguiar, M. C. (2014). Root Cause Analysis: survey of methods and exemplification. Rio de Janeiro, PUC-Rio.
- [2] Almeida, I. M. (2006). Trajectory of accident analysis: the traditional paradigm and the beginnings of expanding the analysis. *Interface*, Botucatu, v. 10, n. 19, p. 185-202.
- [3] ABNT - Brazilian Association of Technical Standards. NBR 14280 (2001): Occupational accident registration - Procedure and classification. Rio de Janeiro: ABNT.
- [4] National Association of Labor Attorneys - ANPT (2019). Digital observatory. Retrieved on 10/12/2019 from: <http://www.anpt.org.br/imprensa/noticias/3468-observatorio-digital-aponta-perda-de-17-mil-vidas-em-acidentes-de-trabalho-from-2012-to-2018?highlight=WYJhY2lkZW50ZXMiXQ>.
- [5] Brazil (2019a), Federal Government. Law No. 6514, of December 22, 1977. Amends Chapter V of Title II of the Consolidation of Labor Laws, concerning occupational safety and medicine and provides other measures. Available at <http://trabalho.gov.br>. Accessed in April 2019.
- [6] Brazil (2019b). Law 13,467, of July 13, 2017. Amends the Consolidation of Labor Laws (CLT), approved by Decree-Law No. 5,452, of May 1, 1943, available at [http://www.planalto.gov.br/ccivil\\_03/Decreto-Lei/Del5452.htm](http://www.planalto.gov.br/ccivil_03/Decreto-Lei/Del5452.htm). Accessed in April 2019.
- [7] Castro, T. R., & Okawa, C. P. Audit of Occupational Safety and Health in a Food Industry in the State of Paraná. *Produção Online Magazine*, 16 (2), 678-704. 2016.
- [8] Chi, S. ; Han, S. ; Kim, D. Y. (2012). Relationship between unsafe working conditions and workers' behavior and impact of working conditions on injury severity in US construction industry. *Journal of Construction Engineering and Management*, v. 139, n. 7, p. 826-838. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000657](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000657).
- [9] Da Costa Almeida, L. et al. (2019). BPMN and quality tools for process improvement: a case study. *Gepros: Production, Operations and Systems Management*, v. 14, n.

- 4, p. 156. doi: DOI: <https://doi.org/10.15675/gepros.v14i4.2308>
- [10] De Oliveira, F. et al. (2007). The persistence of the notion of an unsafe act and the construction of guilt: discourses on work accidents in a metallurgical industry1. *RBSO*, v. 32, n. 115, p. 19-27.
- [11] De Oliveira, Ualison Rébula et al. (2017). The ISO 31000 standard in supply chain risk management. *Journal of Cleaner Production*, v. 151, p. 616-633,
- [12] Filgueiras, V. A. (2012). State and labor law in Brazil: employment regulation between 1988 and 2008. 471 f. Thesis (Doctorate in Social Sciences) - Faculty of Philosophy and Human Sciences, Federal University of Bahia, Salvador.
- [13] Geminiani, L. ; Smallwood, J.J; Fee, S. (2013). A comparative analysis between contractors 'and inspectors' perceptions of the department of labor occupational health and safety inspectorate relative to South African construction, *Saf. Sci.* 53. <https://doi.org/10.1016/j.ssci.2012.10.003>.
- [14] Heinrich, H. W. ; Granniss, E. R. (1959). *Industrial Accident Prevention*, McGraw-Hill. New York.
- [15] Jackson Filho, J. M. et al. Concerning the "social acceptability" of work accidents and the unacceptable concept of unsafe behavior. *Brazilian Journal of Occupational Health*, v. 38, n. 127, p. 6-8, 2013. <http://dx.doi.org/10.1590/S0303-76572013000100001>
- [16] Kuendee, P. (2017). Application of 7 quality control (7 QC) tools for quality management: A case study of a liquid chemical warehousing. In *Proceedings of the International Conference on Industrial Engineering and Applications*. ICIEA.
- [17] Llory, M.; Montayel, R. (2010). *L'accident et l'organisation*. Bordeaux: Preventique.
- [18] Namooan, M. ; Albert, A. ; Feng, J. (2018). The Distracted Worker: Effect on Hazard Recognition and Safety Performance. In: *Construction Research Congress*. P. 367-377. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001459](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001459).
- [19] Neto, J. B. et al. (2019). *Integrated management systems: quality, environment, social responsibility, safety and health at work*. São Paulo: Editora Senac.
- [20] NR-12 - SAFETY AT WORK IN MACHINERY AND EQUIPMENT. Available at [https://enit.trabalho.gov.br/portal/images/Arquivos\\_SST/SS T\\_NR/NR-12.pdf](https://enit.trabalho.gov.br/portal/images/Arquivos_SST/SS T_NR/NR-12.pdf). Accessed in April 2019.
- [21] Reason, J. (2017) *The human contribution: unsafe acts, accidents and heroic recoveries*. CRC Press.
- [22] Sharma, R. K. and Sharma, P. ; Methodology and Theory System Failure Behavior and Maintenance Decision Making Using RCA, FMEA and FM. *Journal of Quality in Maintenance Engineering*, v.16, n. 1, p. 64-88, 2010.
- [23] Tong, R. et al. (2018). Characteristic analysis of unsafe behavior by coal miners: multi-dimensional description of the pan-scene data. *International journal of environmental research and public health*, vol. 15, n. 8, p. 1608, <https://doi.org/10.3390/ijerph15081608>.
- [24] Vilella, R. A. G. ; Iguiti, A, M; Almeida, I. M. (2007) Guilt of the victim: a model to perpetuate impunity in accidents at work. *Public Health Notebooks*, Vol. 20, p. 570-579.
- [25] Zhang, P. et al. (2019). An agent-based modeling approach for understanding the effect of worker-management interactions on construction workers' safety-related behaviors. *Automation in Construction*, v.97, p.29-43. <https://doi.org/10.1016/j.autcon.2018.10.015>.

Table 1: Analysis of the accident 147.

<b>Description of the Accident:</b> Two mechanics were carrying out maintenance on the decanter 3 pipe, they started the intervention on the pipe, however when the racket was removed from the pipe, it was still with steam and hot broth and this due to the pressure of the line was against employees. One of the employees involved was hit in the neck by the hot broth causing a slight burn, the other employee not to be reached jumped in the direction of another nearby tank and when he fell he stepped on the wrong causing a slight injury.
<b>Observation obtained in the accident registration worksheet:</b> Pointed out as an unsafe act due to the fact that they could not have started maintenance with the equipment above room temperature.
<b>1st Why:</b> Why was there an injury? The tubing was disassembled while still pressurized and with heated liquid.
<b>2nd Why:</b> Why was the pipeline pressurized and with heated liquid? As the equipment (decanter) was in operation, the only way to depressurize was to loosen the racket from the pipe.
<b>3rd Why:</b> Why was it the only form of depressurization? There was no depressurization system installed, like a relief valve.
<b>4th Why:</b> Why was there no relief valve installed? It was not foreseen in the project.
<b>5th Why:</b> Why was it not foreseen in the project? There was no request for such a device by the company.
<b>Legal Analysis:</b> According to NR 12 (NR12, 2019), in item 12.77: Additional measures must be adopted to protect hoses, pipes and other pressurized components subject to possible mechanical impacts and other aggressive agents, when there is a risk.
<b>Risks Identified by the RCA Methodology:</b> 1- Lack of safety device (relief valve).

2- Lack of detail and requirements related to work safety, by the project sector when purchasing equipment

Table 2: Analysis of the accident 151.

<b>Description of the Accident:</b> Due to the vinasse booster pump having a problem and the other without a motor, the employee went to turn on the 3rd backup pump and open the valve, it was very dark and he stepped on the wrong side when he climbed over the pipe fall on the channel. It was full of hot vinasse.
<b>Observation obtained in the accident registration worksheet:</b> Pointed out as an unsafe act due to the fact that it could not have climbed in the pipeline to open the valve.
<b>1st Why:</b> Why was there an injury? Due to the fall of the employee who climbed the pipe.
<b>2nd Why:</b> Why was there a fall? Why did he climb the pipe.
<b>3rd Why:</b> Why did he climb the pipe? Because there was no access or platform to perform the operation.
<b>4th Why:</b> Why was there no platform for the operation? It was not foreseen in the project
<b>5th Why:</b> Why was it not foreseen in the project? There was no request for such a device by the company.
<b>Legal Analysis:</b> 1- According to NR 12 (NR12, 2019), in its item 12.64): Machines and equipment must have permanently fixed and safe accesses to all its points of operation, supply, insertion of raw materials and removal of processed products, preparation, maintenance and constant intervention. 2- According to NR 12 (NR12, 2019), in its item 12.94, it defines in its paragraphs "f", "g" and "h": f) favoring the performance and reliability of operations, with a reduction in the probability of failures in the operation; g) reduction in the demand for strength, pressure, gripping, flexing, extension or twisting of the body segments; h) the lighting must be adequate and available in emergency situations, when entrance is required.

#### Risks Identified by the RCA Methodology:

- 1- Lack of secure access.
- 2- Lack of ergonomic design
- 3- Lack of lighting.

Table 3: Analysis of the accident 4.

<b>Accident Description:</b> Employees G1, G2 and G3 performed the operation of coupling and uncoupling the steel cables that have the function of tilting the body of the cane truck. After unloading the cargo, operators G1e G2 unhooked the hooks of the steel cables from the rings of the trucks. In a given situation, operator G3 gave the signal for the truck to be released and the truck started moving. However, the task had not yet been completed by the collaborator G1, who was still removing the ring from the truck when it loosened, hitting his face (injuries to his face and broken teeth).
<b>Observation obtained in the accident registration worksheet:</b> In the accident registration, the operator G3 was pointed out, who was not aware of the operations of the G1 and G2 employees. According to the G3, he informed that he was mistaken when he confused the G1 with another collaborator of the plant (who did not work in that sector) and that he was at the site, also arguing that, as it was night he had difficulty in recognizing.
<b>1st Why:</b> Why was there an injury? G3 authorized the truck to move without the task having been completed.
<b>2nd Why:</b> Why did G3 authorize the truck to move without the task having been completed? Believing that the employee he had seen outside the risk area was G1.
<b>3rd Why:</b> Why was there a confusion of characters? a) Why a fourth employee of the company was in the place that would normally be the G1. b) Why the lack of light contributed to the confusion of characters.
<b>4th Why:</b> Why was this fourth character in that location? There was no restriction on staying there. Why was the place in low light? Why the fixtures lacked maintenance.
<b>5th Why:</b> Why was there no restriction if it is a risk area? Lack of operational management. What is the reason for the lack of maintenance? Lack of operational management



**Legal Analysis:**

1- According to NR 12 (NR12, 2019), in its item 12.8.2, circulation areas and spaces around machines must be designed, dimensioned and maintained so that workers can move safely. Thus, a controlled or isolated area should be provided that would not allow the movement of strangers to function.

2- According to NR 12 (NR12, 2019), in its item 12.95, “The controls of the machines and equipment must be designed, built and maintained in compliance with the following aspects: ... c) visibility, identification and signaling that allows them to be distinguishable from each other; ... e) guarantee of safe maneuvers in order to avoid involuntary movements ”.

**Risks Identified by the RCA Methodology:**

- 1- Mechanisms that prevent involuntary actions of starting machines
- 2- Analysis and adequacy of NR 12
- 3- Neglect of the sector leadership regarding the aspects of maintenance and operation management